DETERMINATION OF AEROSOL CONTENT IN THE ATMOSPHERE FROM ERTS-1 DATA

Progress Report No. 6

Contract No.: NAS5-21860

Period Covered: 7 July 1973 to 6 September 1973

Proposal Number: 245

GSFC ID Number: P135

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Prepared for:

GODDARD SPACE FLIGHT CENTER

7 September 1973

ACCOMPLISHMENTS

Significant results have been obtained during this sixth two-month period of the contract. A useful empirical relationship between contrast at the Salton Sea/desert test site and the aerosol content has been found for MSS 4, 5 and 6. Recent data have shown that care must be taken in using the radiance to infer aerosol content over water surfaces when effluents are apparent in the water. Analysis of desert data has shown, as predicted by theory, that the radiance over high albedo surfaces is insensitive to aerosol variations.

GROUND-TRUTH MEASUREMENTS

A NASA aircraft overflight at the Salton Sea/desert test site was scheduled for Aug. 21, 1973, but due to bad weather forecast for the area on that date, the overflight was cancelled, and tentatively rescheduled for Sept. 8, 1973. No ground-truth measurements were made at San Diego in this reporting period due to cloud cover at the time of the ERTS-1 overpasses.

The digital data from the NASA aircraft overflight on May 23, 1973, has not yet been received.

DIGITAL DATA ANALYSIS

The digital data for two more overpasses at the Salton Sea have been received and analyzed. The data for two additional overpasses have been requested; copies of the request forms are given at the end of this report.

Radiance-Aerosol Content Relationship (Water Surface)

The results presented in Progress Report No. 5 have been modified due to a revised lower Volz value for the Atlantic point; this results in a slight increase in the slope of the straight line fit to the data. The new plot of the radiance-aerosol content relationship is shown in Fig. 1, together with the results for MSS 7, not previously shown. The MSS 7 data are not considered useful due to the low signals at these longer wavelengths, and due to the influence of water vapor absorption in this bandpass.

Since the previous report, another data point, for May 5, 1973, has been obtained. The photographic images for this day showed what appears to be irrigation effluents in the Salton Sea, resulting in variable high radiances over the water surface. An area exhibiting the lowest values of radiance was selected, but as seen in Fig. 1, the radiances appear too high (in comparison with previous data) for the measured aerosol content, especially for MSS 5 and 6. The effluent pattern is more apparent in the photographic images at shorter wavelengths. However, the radiance vs. aerosol content data point of MSS 4 shows less deviation from the previous data than at the longer wavelengths. In addition, the spectral variation of radiance, seen in Fig. 2, has the same basic shape as previous data. Thus, the spectral behavior of this effluent, and its effect on aerosol observations is not completely consistent, and further studies of this type of data are required. However, it is clear that care should be taken in using data from bodies of water where effluents occur on an intermittent basis. The data may be readily screened by visual examination of the photographic images.

Radiance-Aerosol Content Relationship (Desert Surface)

The variation of desert radiance was investigated by plotting in Fig. 2 the radiance in MSS 6 against the aerosol content, as determined from the

Salton Sea radiance and the relationship for MSS 6 in Fig. 1. The data, uncorrected for sun angle, appears to show a good linear relationship. However, after normalizing to a sun angle of $\mu = .45$, using the theoretical variation for an albedo of 0.4 given by Plass and Kattawar (Appl. Opt. 7, 1130, 1968), the radiance clearly shows no dependence on the aerosol content, just as we had predicted for high albedos. However, this technique should be further investigated for intermediate albedos, like 0.15 - 0.20 for urban areas.

Contrast-Aerosol Content Relationship

The values of $(C_0/C_R - 1)$ discussed in Progress Report No. 5 have been revised due to a previously incorrect method of normalizing the values to a sun angle of $\mu = 0.45$. The revised data are shown in Fig. 4 as a plot of $(C_0/C_R - 1)$ vs. aerosol content. The intercept on the abscissa is determined for the hypothetical case of no atmosphere when $C_0 = C_R$; and is given by the negative value of $(\tau_R/\tau_A)N$ where τ_R is the Rayleigh optical thickness, τ_A is the Elterman 1964 model aerosol optical thickness, both for the center wavelength of the MSS channel, and N is the Elterman 1964 model aerosol content. It is seen that a linear relationship is found for MSS 4 and 5, but a non-linear one is found for MSS 6. MSS 7 is not considered due to its low values of water radiance.

Thus, it appears that contrast of natural targets can be used for determining the aerosol content of the atmosphere. The technique should be further investigated for both the Salton Sea/desert site and other natural targets.

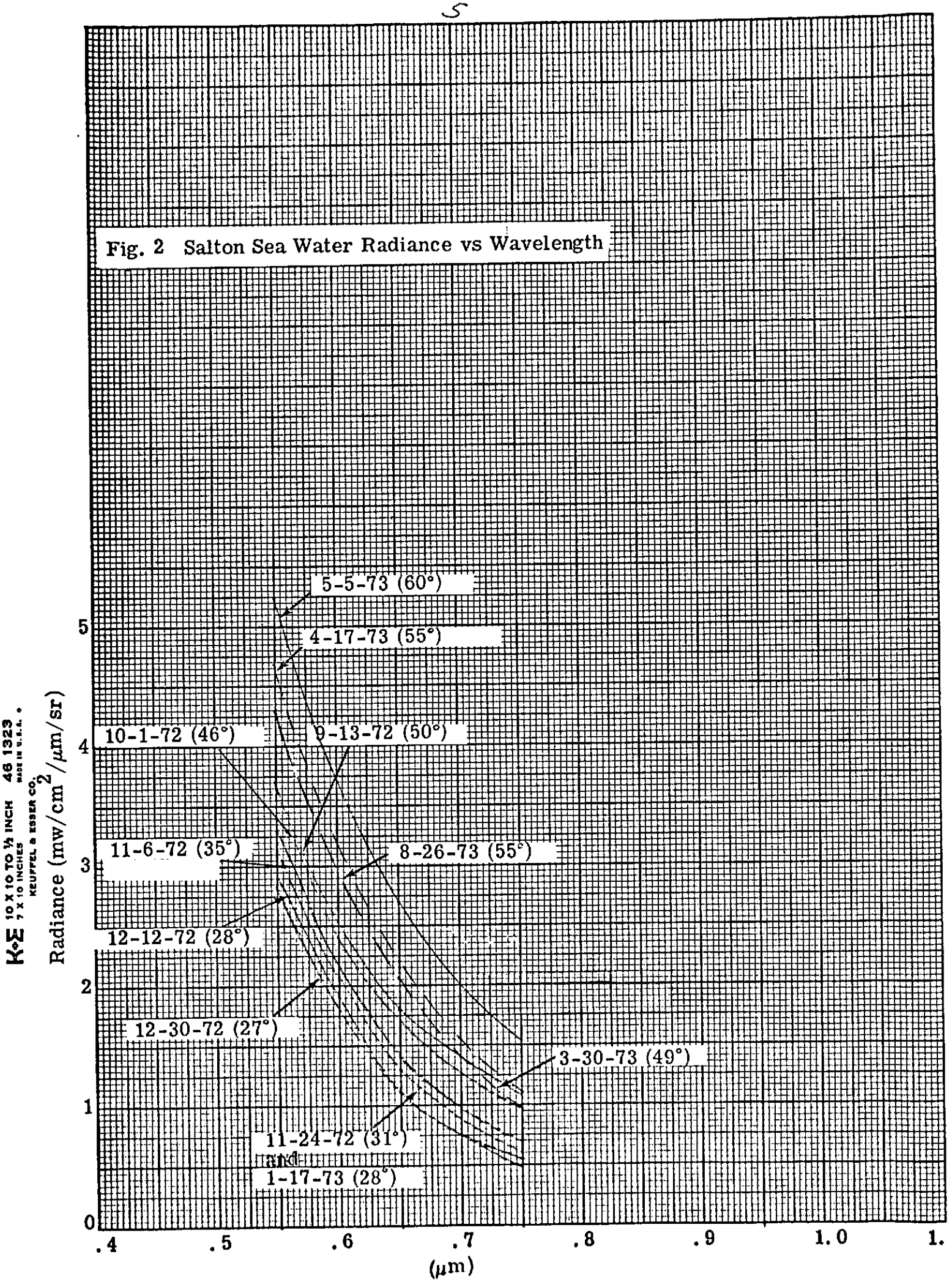
FUTURE PLANS

Phase III activity ends on Oct. 6, 1973, so that only data received and analyzed by that date will be included in the draft copy of the final report due Nov. 6, 1973.

SIGNIFICANT RESULTS

Useful empirical relationships between apparent contrast at the Salton Sea/desert test site and the aerosol content of the atmosphere have been found for MSS 4, 5 and 6. This provides another technique to measure the atmospheric aerosol content, in addition to the method of measuring radiance over water surfaces previously reported. Analysis of desert data has shown, as predicted by theory, that the radiance over high albedo surfaces is insensitive to changes in the aerosol content of the atmosphere.

Fig. 2 Salton Sea Water Radiance vs Wavelength



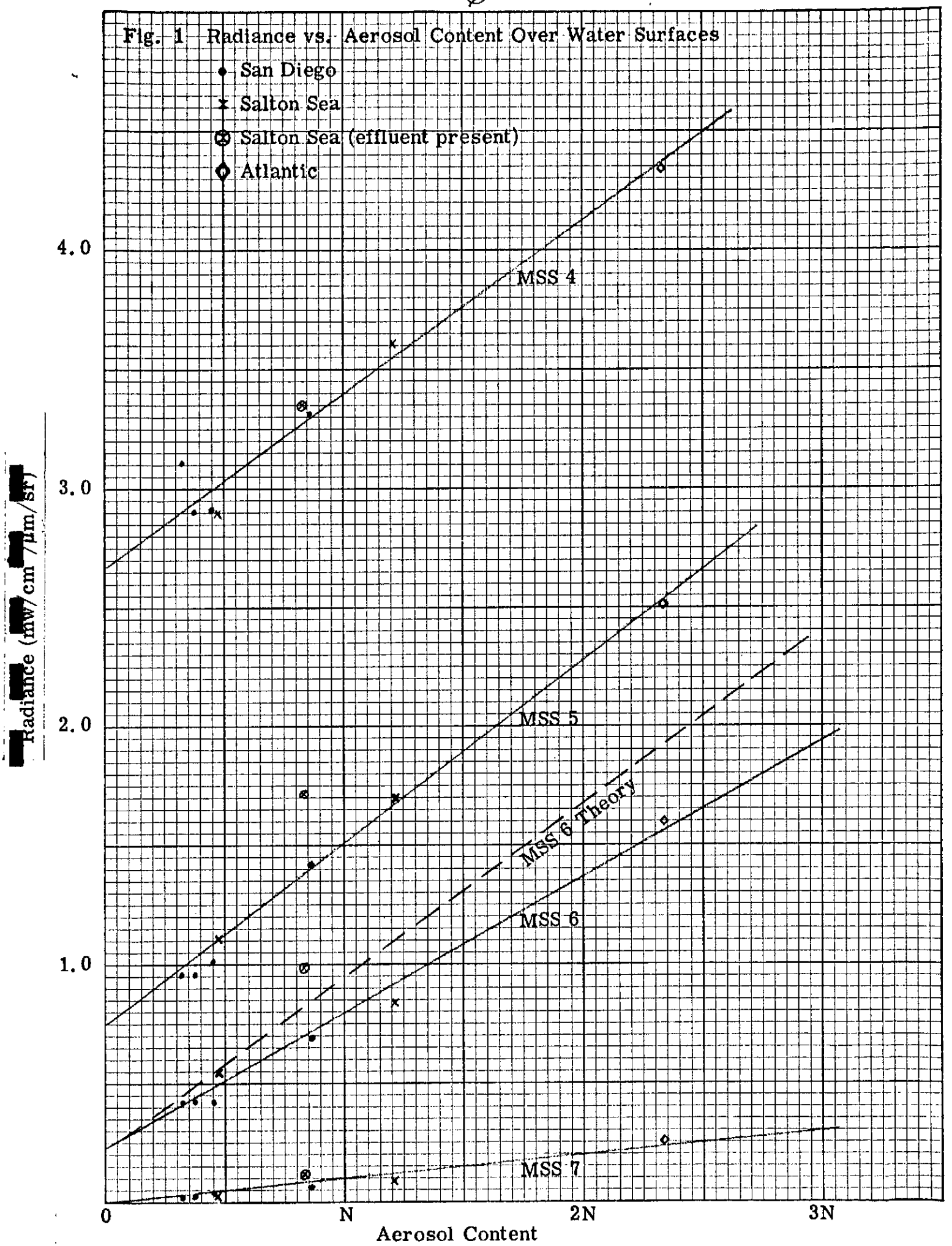


Fig. 1 Radiance vs. Aerosol Content Over Water Surfaces
San Diego
Salton Sea
Salton Sea (effluent present)
Atlantic
MSS 4
MSS 5
MSS 6 Theory
MSS 6
MSS 7
4.0
3.0
2.0
1.0
0
N
2N
3N
Aerosol Content
Radiance (mw/cm²/μm/sr)

Fig. 3 Desert Radiance vs. Aerosol for MSS 6

● Uncorrected for Sun Angle

× Normalized to $\mu = .45$

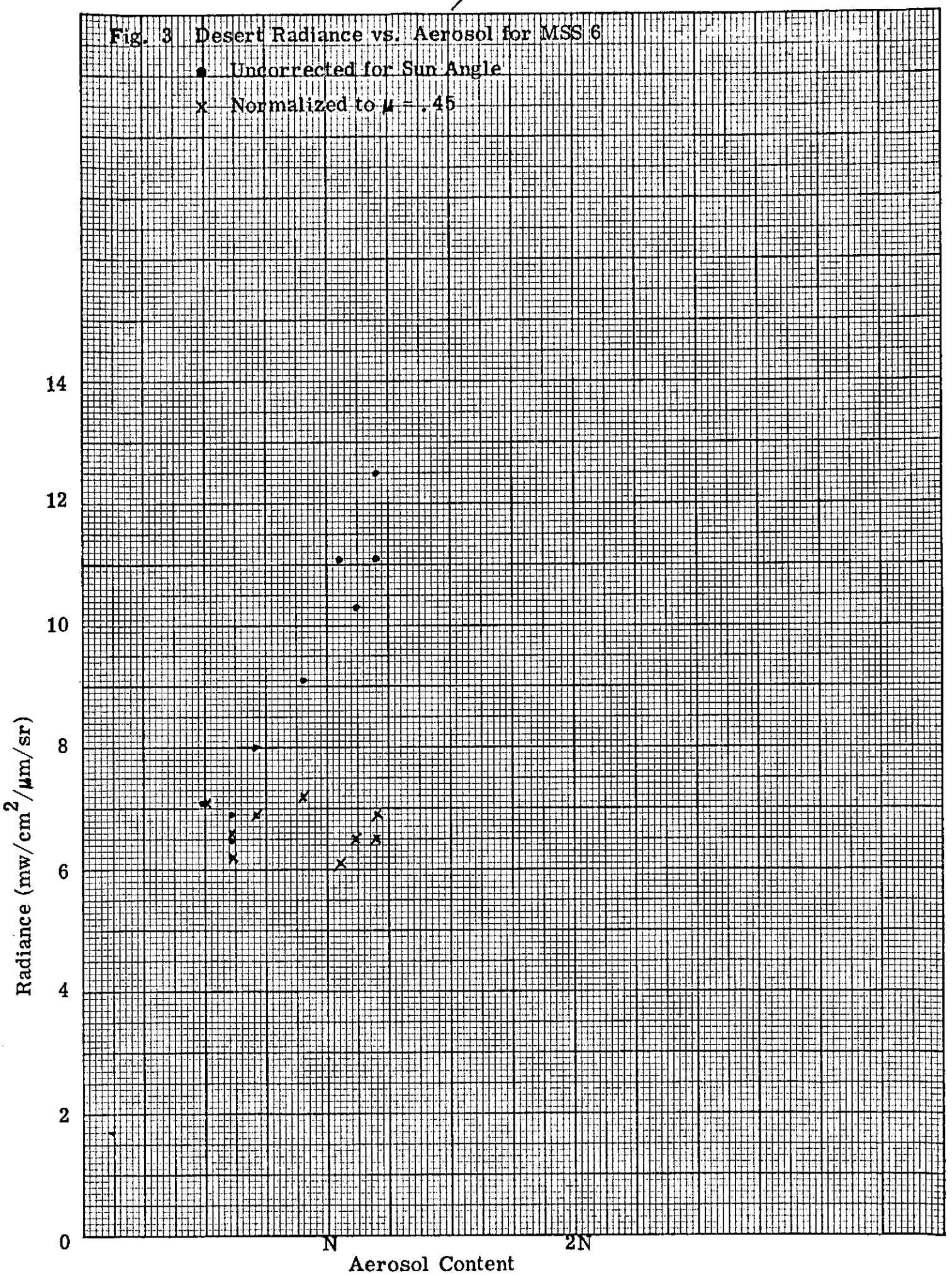
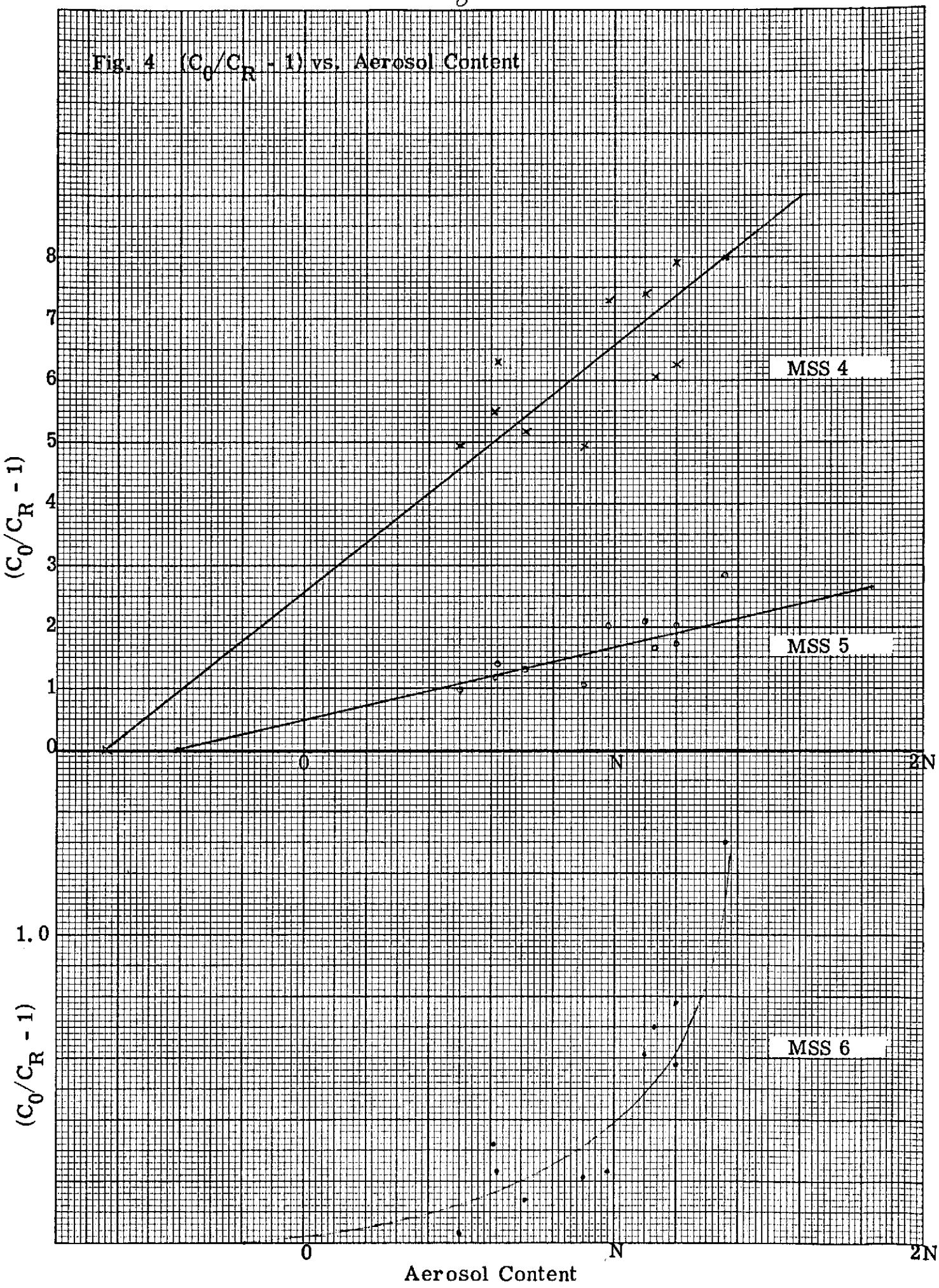


Fig. 4 $(C_0/C_R - 1)$ vs. Aerosol Content



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TM

DATA REQUEST FORM

1. DATE Aug 2 1973

2. USER ID PR135

4. SHIP TO:

ADDRESS Dr. M. GRIGGS ☐ NEW

SCIENCE APPLICATIONS INC

P.O. BOX 2351

LA JOLLA CA 92037

5. TELEPHONE NO. (714) 459-0211 ☐ NEW

6. CATALOGUES DESIRED

STANDARD ☐ U.S. ☐ NON-U.S.

DCS ☐

MICROFILM ☐ U.S. ☐ NON-U.S.

APPROVAL TECHNICAL MONITOR _____

ADDDHHMMS OBSERVATION IDENTIFIER	C CENTER POINT COORDINATES	B SENSOR BAND	P PRODUCT TYPE	F PRODUCT FORMAT	T TICK MARKS	NN NUMBER OF COPIES	A AF
[redacted]04-17504	N33-16/ W116-10	M	D	7		1	U
[redacted]2-17503	N33-16/ W116-13	M	D	7		1	U

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ID_____
AA_____
TM_____

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